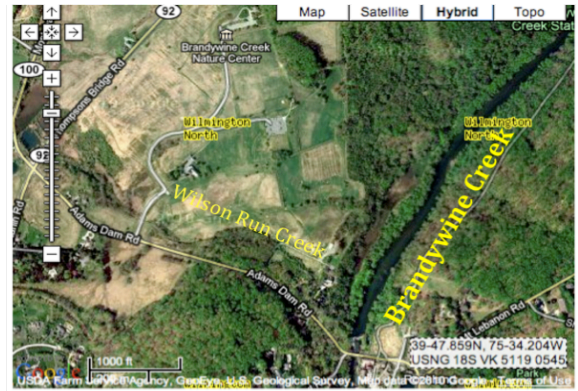


Background Information: The Brandywine Creek

Location

Brandywine Creek is the result of the interaction of landforms, water, and gravity. Wilson Run Creek is located in Brandywine Creek State Park, in northern Delaware. Wilson Run Creek feeds into Brandywine Creek, which is a tributary to the Delaware River.



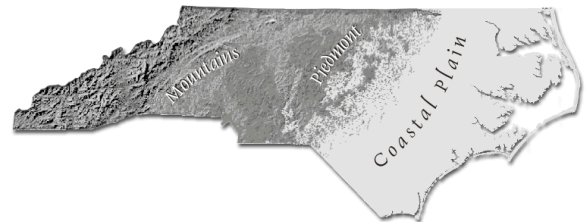
The USGS Store: Map Locator

Due to the location of Brandywine Creek, towns developed using the creek's energy for agricultural and industrial production. Specifically, it was the energy of waterfalls that allowed the DuPont family to become a leader in industry.¹

Relief

In this region of northeast North American, the Appalachian Mountains are a predominant geological feature. The mountain system rises to a height of 6,684 ft (2,037 m). Comparatively, the Rocky Mountains in western North America are much higher, reaching above sea level approximately 14,433 ft, an equivalent of 4,399 m.²

North Carolina Office of Archives & History ...



The Piedmont is at the foot of the Appalachians and in contrast reaches an elevation of approximately 400 ft or 122 m above sea level.³ The rolling hills of the state of Delaware are

¹ North, pg 1

² Major Landforms Of North America

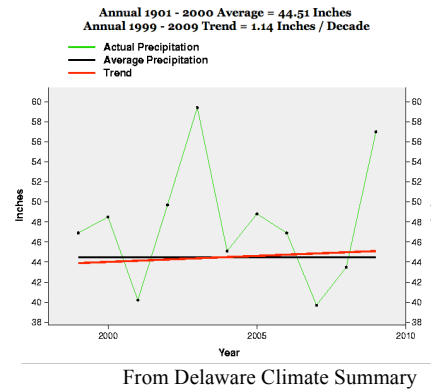
³ Plank, pg 15

Background Information: The Brandywine Creek

reflective of the gently declining slope of the Piedmont as it approaches the Coastal Plain abutting the Atlantic Ocean.

General Climate

This area of northeastern North America is dominated by deciduous forests and has a temperate climate. Based on data from the National Oceanic and Atmospheric Administration, during a 10-year period, the average precipitation for Delaware is approximately 44.51 inches or 113.05 cm, with the average temperature, for this same period, of 54.72 F.⁴



Knowing the climate is important because water is a major agent of change; it has power to cut and carry material for long distances, thereby sculpting the surface of the earth. This in turn means that the channels and topography of Delaware are almost always under the influence of flowing water.

Geologic Setting Of The Park

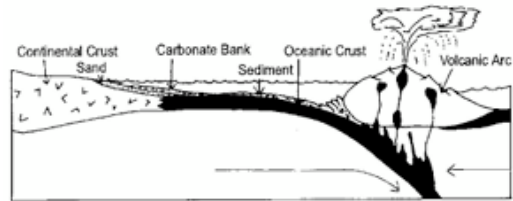
The Brandywine Creek lies in the eastern foothills of the Appalachian Mountains, referred to as the Piedmont. The mountain range is the result of plate tectonics and extends south from Alabama, continuing northeast into Maine and Canada, with sister ranges in Greenland and Europe.

⁴ Delaware Climate Summary

Background Information: The Brandywine Creek

The materials from which the Appalachian Mountains are formed are the erosional remains (sand, silt, clay) from an ancient mountain, Grenville, and carbonate remains (shells) from the ancient Impetus Ocean that lay between ancient North America and Africa. The Grenville Mountains existed before the first multi-celled organisms 570 mya and well before the supercontinent of Pangaea.⁵

Ancestral North America was at the leading edge of this subduction zone, where its oceanic crust was pulled under the edge of ancient Africa during the formation of Pangaea during the Ordovician period. Interplate collision heated the lithospheric crust that became a source of magma. Typically as rock is heated to melting some of the molten material will rise and erupt as lava at volcanic sites. At this plate boundary of ancient North America and Africa a volcanic arc formed approximately 543 mya. This period of Appalachian mountain building is referred to as the Taconic Orogeny.⁶



From Plank, pg 28

There have been multiple mountain building events or orogenies since the Taconic Orogeny. The Acadian and Alleghanian orogenies created additional deformation and thrust the range to an elevation reasoned to be higher than the Himalayas.⁷ As a result of the many deformations no fossils have been found in the metamorphic rock, even though 543 mya correlates to the Cambrian period when shelled organisms evolved.⁸

⁵ Plank, pg 19

⁶ Northeast Geologic History, pg 15

⁷ Northeast Geologic History, pg 14

⁸ Plank, pg 22

Background Information: The Brandywine Creek

Specifically, as the Appalachians eroded down to its current day elevation (2,037 m) the removed sediments was laid on top of older layers. The weighted material eventually sank into the mantle where it underwent metamorphism due to pressure and heat. As erosion wore down the Appalachian Mountains, the additional sediments from millions of years have been transported by water, due to gravity's effect, to the Coastal Plain laying at lower elevations and abutting the Atlantic Ocean.

Types And Ages Of Rocks

Over millions of years the Appalachian Mountains have steadily eroded. As a result the mountain has rebounded to expose what was once the core of the mountain, the Piedmonts. Subsequently, the rocks are metamorphic as they were subjected to heat and pressure from burial in the mantle.

The predominate rock of the Piedmont in Delaware is gneiss (referred to as Wilmington Blue Rock and nick named Brandywine Blue Granite, though it contains no granite), and is banded with light and dark minerals. The light mineral is quartz and the darker minerals are pyroxene and feldspar. Due to its resistance to erosion, Gneiss has long been used as building stone for construction.

Wilmington Blue Rock



Other commonly known metamorphic rocks of the area are schist, quartzite, and marble. A commonly known igneous rock of the area is granite, and less known is gabbro

Background Information: The Brandywine Creek

(coarse-grained with greenish-white feldspar and pyroxene). Gabbro is a basaltic rock that intrudes into parent rock.⁹

Erosion And Deposition Of Sedimentation

As water in the channel courses through the landscape, it will shape the surface by cutting and then depositing material from its channel. The cuts along the bank are referred to as the cut bank.

Where debris is deposited along the channel it is referred to as the point bar. Where the velocity of water is greatest there will be more erosion, while areas of low velocity will result in material dropping out. When streams slow down the material or sediment drops out, with the larger materials first to the finest last. In this manner, streams act as a vehicle for sorting sediment.

Within the channel there are various depths and velocities of water flow. The velocities of a channel change with depth and volume of water within the channel; as the volume of water increases, so to does velocity and depth. Due to frictional force velocities will be lower along the extreme edges and bottom of the channel. As there is typically less material in the center, the velocity will be greatest in the middle of the channel.

Presence And Nature Of Streams

As gravity pulls water down, particles are loosened and transported. The transported material acts as an abrasive force and cuts into the landscape forming rills or small channels.

⁹ Plank, pg. 20

Background Information: The Brandywine Creek

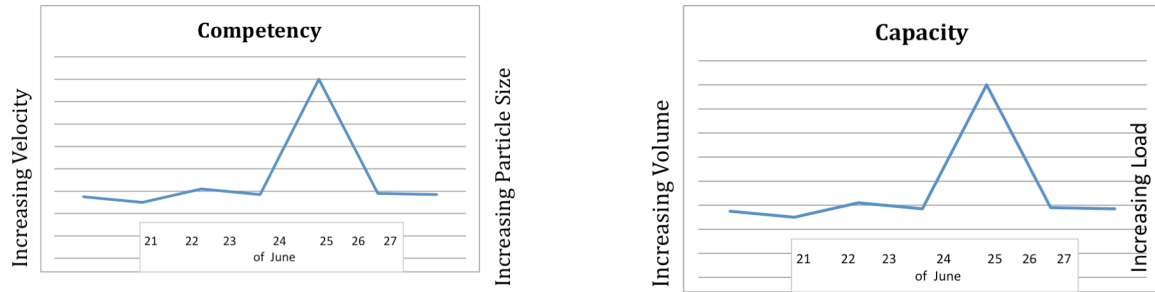
Over time, with the increased volume and hydraulic force of water, the channel will widen and deepen thereby cutting into sedimentation and solid bedrock. These are the processes from which a channel evolves.

The Effect of Velocity on Particle Size

Channels, focusing specifically on streams, transport the material they carry. This material is defined by how it is transported. Dissolved load is the finer material or sediment and is dispersed throughout the water. It is measured as parts per million due to its significantly small size. It is brought to the channel by ground water. Suspended load is sediment that is typically visible as the 'cloudy' material that makes waters murky. It consists of silts and clays and during floods can include sand and gravel. Lastly, the bed load consists of larger sediments that line the bed of the channel, such as boulders, gravel and sand. This sediment is usually too heavy to be transported by the flow of the stream, but it will roll along the bottom when the water is moving at high velocities.

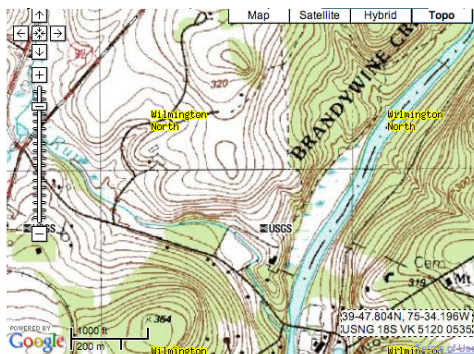
The ability of a stream to transport material by maximum size is referred to as competence. Competence is directly related to the velocity of the channel; the higher the velocity, the bigger the sediment that can be transported. Another factor that relates to transportation of the stream is capacity. Capacity is the maximum load the stream can carry and is directly related to discharge or the amount of water in the channel. If the channel has a high amount of water, then more material can be carried by volume and size.

Background Information: The Brandywine Creek

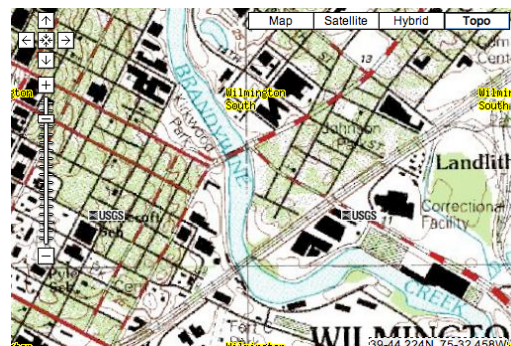


As an example, above is a graph showing the discharge of the Brandywine at Chadds Ford monitoring station during June.¹⁰ As stated above, discharge and velocity sculpt features of the landscape as illustrated by contour lines in topography maps. It is important to understand these processes because as material is transported, features can be created and destroyed.

Near the top of the stream head, the channel is narrower as the energy of the stream is down cutting into the bed. As the channel continues it will begin to cut away at the sides of the bank where velocity is least. As sediment is eroded from the cut bank it will be transported in the water and will deposit along point bars eventually making the channel wider. As time and distance from the stream head increase so too will the width of the valley, which will begin to widen as it approaches base level and is primarily eroding the along the banks of the channel.



Brandywine Creek at Wilson Run, near head of creek showing increased slope



Flatter slope as creek approaches Delaware River in the City of Wilmington

¹⁰ National Water Information System

Background Information: The Brandywine Creek

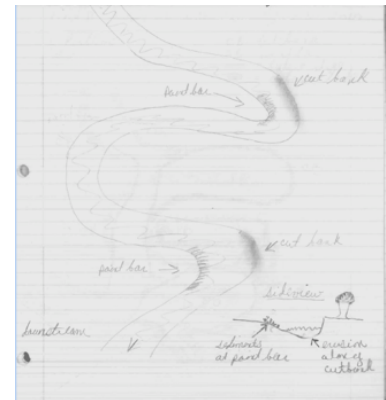
Comparing the above figures¹¹, note that the contour lines, given in 10-meter intervals, represent slope. The relationship of line spacing and slope is inverse. In general, as the contour lines get closer, the slope of elevation becomes steeper. As seen above, the maximum elevation is 364-meters (in the bottom left corner). The elevations along the banks of Wilson Run Creek are 200-meters on the west bank and 190-meters on the east bank. Conversely the elevations along the banks of the creek, as it approaches the mouth of the Delaware River in Wilmington, is 5-meters on the west bank and 10-meters on the east bank.

Meandering Streams

A stream sweeps laterally, is referred to as a meandering stream. These channels erode their banks on the cut bank and deposit sedimentation along the point bar.¹² Meandering

streams develop as described under the section *Presence And Nature Of Streams*. They attract development because of the

surrounding resources of water, land, and agriculture. For this reason (though not the only) they are studied. The implications of removal of land at cut banks versus addition of land at point bars is useful information when planning for future land use.



Sketch of Meandering Stream

¹¹ The USGS Store

¹² Tarbuck, pg 123

Background Information: The Brandywine Creek

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Web site publishes various geologic and geographic maps, including topographic, of the United States.